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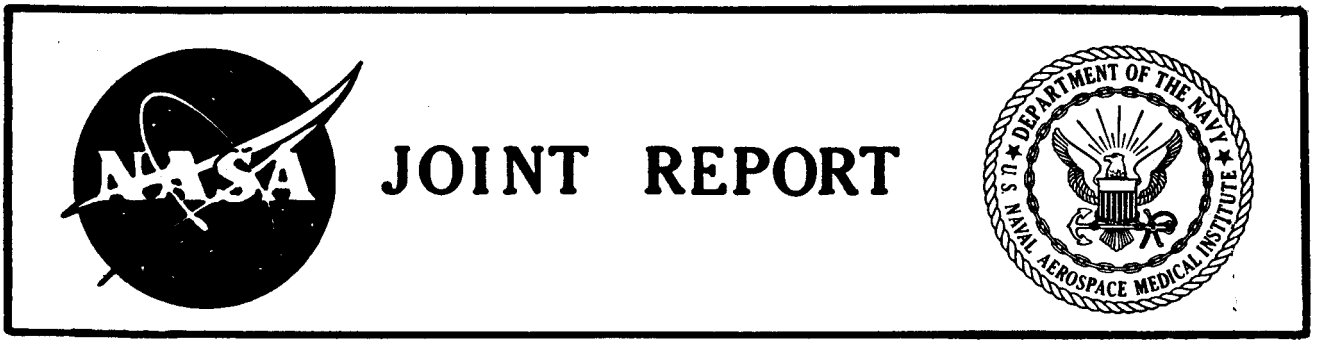
AN ATAXIA TEST BATTERY NOT REQUIRING THE USE OF RAILS

Alfred R. Fregly and Ashton Graybiel



NAVAL AEROSPACE MEDICAL INSTITUTE

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

December 1966

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Fregly, A. R. 1966
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Significant decreases in performance with age and an apparent superior performance by males were found. The scores of bilateral and unilateral vestibular-defective individuals and of patients referred for testing because of symptoms of vertigo departed significantly from the normative standards. The usefulness of individual tests as well as of the test battery in clinical and research situations was made apparent.

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Bureau of Medicine and Surgery
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Commanding Officer

6 December 1966

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PENSACOLA, FLORIDA

SUMMARY PAGE

THE PROBLEM

Devise a quantitative ataxia test battery not requiring the use of rails.

FINDINGS

Individuals with bilateral or unilateral vestibular defects as well as those referred for testing because of symptoms of vertigo obtained performance test scores significantly different from the normative standards. The usefulness of individual tests as well as the entire battery for clinical and research purposes is pointed out.

ACKNOWLEDGMENTS

Gratitude is expressed to those many individuals who made this work possible. We are especially indebted to Drs. Paul H. Nieberding, James R. Nelson, Robert E. Mitchell, Albert Oberman, Lawrence E. Thomas, James M. Haynes, and William F. House, to Lt Robert S. Kennedy MSC USN, and above all to Mr. Theron L. Trimble and the vestibular-defective subjects.

INTRODUCTION

The new quantitative ataxia test battery described recently (7) included normative standards only for those tests performed on rails. In the present report normative standards are presented for the remaining tests in the battery which exploit the floor as a walking and standing platform. It is shown that the "floor ataxia test battery" (FATB) discriminates among abnormal and between normal and abnormal subjects. Advantages in clinic and experimental situations where the use of rails is not feasible are demonstrated.

PROCEDURE

SUBJECTS

The "normal" male subjects were military and civilian personnel examined for the purpose of establishing normative data on a larger battery of postural equilibrium-ataxia tests (7). They included members of The Thousand Aviator group (5); student aviators; Project Astronaut Candidates (1); highly experienced aviators, including instructors and test pilots; flight surgeons; other military officers and enlisted personnel; technical, scientific, and biomedical personnel; college professors and students; senior citizens and others representing numerous occupations.

The "normal" female subjects were military and civilian scientific, medical, technical, and administrative personnel; housewives; college and high school students; and senior citizens.

All "normal" subjects were in good to excellent health and free of any known vestibular or otoneurological disturbance.

The nonnormal samples were obtained from unilateral labyrinthine-defective individuals, including some who had been treated with streptomycin for Ménière's disease (8) and those treated surgically for acoustic neurinoma (9), bilateral labyrinthine defectives who incurred meningitis or mastoiditis early in life (6), and otoneurological patients with vertigo as a major symptom or complaint. The diagnosis in the great majority of this latter group either was tentative or incomplete. Those for whom either a tentative or final diagnosis was available included: vestibular neuronitis typical and atypical, Ménière's disease, postural vertigo, positional nystagmus, labyrinthine artery occlusion, post-traumatic pseudobulbar palsy, acoustic trauma, longstanding deafness, orthostatic light-headedness, cerebral vascular insufficiency, and psychogenic disorder.

All labyrinthine-defective individuals were in good to excellent health, and the health and physical fitness of the otoneurogical patients were adequate, or better, for undergoing testing.

METHOD

All tests were undertaken on a hard floor, with subjects in the stringent body position of arms folded against chest, feet (shoes on) heel-to-toe and tandemly aligned (SOLEC and classical Romberg tests excepted), and body erect or nearly erect. Administered in the following order, they consisted of the: 1) Sharpened Romberg (SR)--standing with eyes closed for a period of 60 seconds; 2) Stand One Leg Eyes Closed (SOLEC-R and SOLEC-L)--standing for a period of 30 seconds; 3) Walk A Line Eyes Closed (WALEC)--walking a distance of 12 feet in a straight line; 4) Walk On Floor Eyes Closed (WOFEC)--same as WALEC, but scored differently; 5) Classical Romberg.

In instances of extremely poor performance, eyes-open versions of these tests were administered: 6) Sharpened Romberg (SR E/O); 7) Stand One Leg Eyes Open (SOLEO-R and SOLEO-L); 8) Walking a Line Eyes Open (WALEO); 9) Walking On Floor Eyes Open (WOFEO); 10) Classical Romberg (CR E/O).

Administration and scoring procedures are described fully in Appendix A.

This battery of ataxia tests evolved in stages. Whereas all subjects undertook the SR, a smaller number also undertook the SOLEC, fewer still also undertook the WALEC, and still fewer undertook the WOFEC.

Most male subjects wore a military or military-type dress shoe, whereas most female subjects wore flats. The wearing of soft-soled footwear, such as tennis or basketball shoes, was not permitted.

RESULTS

NORMATIVE DATA

Age and sex influences upon SR and SOLEC test performance skills are summarized in Table I. Age groupings were established on a trial and error basis and agree remarkably with results previously reported with the "rail method" (7). Performance capabilities begin to decline in males, apparently, at about age 43 and in females, apparently, at about age 30. Males scored higher than females at all age levels sampled. Age and sex differences in SR performance levels were, generally, of the same magnitude as the age and sex differences on the SOLEC.

Normative standards in the form of raw scores and their percentile equivalents are presented in Appendix B (SR test) and Appendix C (SOLEC test). The standards for females are tentative because of the small number tested. Several striking sex differences were found. For example, 80 percent of the 17-42 year old males and only 42 percent of the 18-29 year old females obtained perfect SR scores; 52 percent of the 17-42 year old males and only 17 percent of the 18-29 year old females obtained perfect SOLEC-R scores. At the low ends of the distributions, an SR score of 96 has a 1st percentile equivalent in the younger males but has a 15th percentile equivalent in the

Table I

Age and Sex Influences Upon SR and SOLEC Test Performance Scores

Groups	Age Range	SR Test N	SR Test Mean	SR Test S.D.	SR Test Mean Diff.	SR Test t	SOLEC-R Test N	SOLEC-R Test Mean	SOLEC-R Test S.D.	SOLEC-R Test Mean Diff.	SOLEC-R Test t	SOLEC-L Test N	SOLEC-L Test Mean	SOLEC-L Test S.D.	SOLEC-L Test Mean Diff.	SOLEC-L Test t
Males	17-42	427	228.4	32.67	65.5	13.8*	215	129.2	33.29	43.0	8.4*	215	129.3	32.15	39.3	7.9*
Females		138	162.9	79.50			65	86.2	44.38			65	90.0	43.77		
Males	18-29	341	228.5	32.41	40.7	8.0*	162	129.7	33.51	28.9	4.6*	162	132.3	30.32	30.3	5.2*
Females		83	187.8	67.19			41	100.8	41.98			41	102.0	41.80		
Males	30-49	622	192.2	68.43	63.8	7.9*	243	93.5	49.49	40.3	4.9*	243	92.5	49.65	34.0	4.1*
Females		87	128.4	84.59			40	53.2	36.79			40	58.5	37.63		
Males	43-50	573	185.7	71.27	71.8	5.5*	209	82.1	48.96	42.6	3.6*	209	83.6	49.86	39.3	3.3*
Females		33	113.9	88.24			18	39.5	31.71			18	44.3	31.12		
Males	51-53	38	175.9	82.06	46.4	1.0	24	78.9	48.52	9.9	0.3	24	71.3	49.45	6.0	0.2
Females		4	129.5	97.81			3	69.0	58.03			3	65.3	59.97		
Males	50-71	76	165.6	81.28	59.0	3.0*	50	72.3	47.28	25.2	1.6	50	70.2	48.02	22.7	1.4
Females		24	106.6	88.40			11	47.1	42.65			11	47.5	43.94		

* $P<.01$

younger females. Similar sex differences in SR and SOLEC scores were found at the succeeding age levels.

Mean performance scores on the right were virturally identical to mean performance scores on the left leg at all age levels in both males and females (Table I). Yet in random samples of thirty males from the successive age groups--17-42, 43-50, and 51-53, only moderate between-legs correlations (.73, .64, and .86) were obtained. Average between-leg differences within individuals (Table II) ranged, generally, from 19.4 to 27.2 seconds. In the 50-71-year-old females the difference was only 4.8 seconds. The proportion of subjects who scored better on the right leg was about equal to the proportion who scored better on the left leg. Moreover, average differences when the right leg was superior to the left generally equalled the average differences when the left leg was superior. The high variability of the between-leg differences (Table II) argue for administration of this test on both legs to maximize comparability of a given subject's performance skill with normative standards. Between-leg discrepancies outside the range of normal variability (Table II) may indicate the workings of significant nonvestibular influences (for example, orthopedic) which may prove worthwhile investigating. With individuals who fail to score a perfect trial on either leg,reliability may be enhanced by continued testing with the procedure of alternating the legs to minimize fatigue.

Table II

Comparisons of SOLEC-R with SOLEC-L Scores by Age and Sex Groupings

N	Age Range	Group	Average Difference Between SOLEC-R and SOLEC-L Scores	S.D. of Differences	Average Differences When R>L*	Average Differences When L>R	Percent N R=L	Percent N R>L	Percent N L>R
215	17-42	M	19.4	24.20	30.7	29.7	35	32	33
209	43-50	M	26.1	27.75	29.4	30.3	13	42	45
24	51-53	M	27.2	28.85	29.9	29.4	9	58	33
41	18-29	F	24.7	26.89	32.1	26.6	14	37	49
40	30-49	F	25.2	25.33	20.9	29.9	2	44	54
11	50-71	F	4.8	4.95	6.8	5.2	17	33	50

* Indicates SOLEC-R greater than SOLEC-L score

There were no significant age or sex differences in WALEC performances. Mean scores and standard deviations were, respectively, in males 10.1 and 7.13 and in females

10.0 and 5.97. Therefore all scores were combined for the calculation of the normative standards presented in Appendix D.

All "normal" subjects free of any known otoneurological disturbance who have undertaken the WOFEC test have obtained perfect scores.

In all instances in which "normal" male subjects who did not obtain perfect scores on the SR and SOLEC tests, and who were administered also the eyes open version of these tests, perfect scores were obtained. In contrast with the males, only 90 per cent of the females so tested attained perfect eyes open scores.

VALIDITY

Comparisons of the SR and SOLEC test performances of the unilateral and bilateral labyrinthine-defective subjects and those patients with vertigo with age-matched "normals" are summarized in Table III. All individual scores of the labyrinthine defectives and virturally all of the group scores including those of the vertigo patients differed significantly from the scores of the "normals" presented in Table I.

Neither the bilateral nor the unilateral labyrinthine-defective subjects were able to meet the criterion of a scorable trial on the WALEC test. Rather, all of these subjects side-stepped while walking with eyes closed. All attempts by these subjects, however often repeated, to walk heel-to-toe eyes closed without side-stepping resulted in marked veering and immediate loss of balance, usually within two to five steps. Their performances on this test with eyes open, however, were equivalent to those of "normals." Also, all of these subjects obtained perfect scores on the WOFEO, SR E/O, and SOLEO tests. Moreover, they performed normally on the Classical Romberg test with eyes closed--a finding which dramatizes the insensitivity of this test to gross vestibular defects.

Generally, performances of the vertigo patients were considerably superior to those of the labyrinthine-defective subjects. In all instances in which eyes-open tests were administered because of imperfect eyes-closed scores, these patients, similar to the labyrinthine-defective subjects, attained perfect scores. Whereas standing with eyes closed (SR and SOLEC) test scores of the otoneurological referrals differed significantly from those of the "normals," inferiority in the WALEC test performance of the male referrals (N=35; mean=13.11) in relation to the "normals" (N=43; mean=10.8) did not attain statistical significance ($t=1.23$).

The marked sensitivity of the ataxia test battery to vestibular deficiencies was further emphasized by the finding that severely and totally deaf individuals with no evidence of vestibular dysfunction as well as a patient with a tentatively diagnosed cerebellar tumor, also without evidence of vestibular dysfunction, attained statistically normal performance scores. In addition, despite much repeated testing of unilateral (8) and bilateral labyrinthine-defective subjects, with one exception (3), the eyes closed

Table III

The SR and SOLEC Test Scores of Vestibular-Defective Individuals and Patients with Vertigo and Their Significance in Relation to Normative Standards of Performance

N	Otological Groups	Age Range	SR Test Mean	SR Test S.D.	SOLEC-R Test Mean	SOLEC-R Test S.D.	SOLEC-L Test Mean	SOLEC-L Test S.D.
			MALES					
23	Bilateral LDs	20-42	15.1**	5.42	14.5**	5.51	12.9**	3.60
2	Bilateral LDs	46-50	18.5**	1.50	12.5*	1.50	11.5*	1.50
1	Ménière's Patient	41	12.0	-	11.0	-	14.0	-
1	Ménière's Patient	50	11.0	-	10.0	-	9.0	-
1	Ménière's Patient	56	9.0	-	12.0	-	11.0	-
1	Unilateral LD	36	27.0	-	24.0	-	24.0	-
4	Unilateral LDs	43-49	34.3**	18.66	25.3*	6.18	28.0*	13.64
2	Unilateral LDs	68-70	11.5**	3.50	11.5	4.50	13.5	4.50
36	Vertigo Patients	19-41	144.7**	88.52	81.0**	48.51	80.3**	52.84
6	Vertigo Patients	45-50	53.7**	27.19	46.3	35.79	46.5	15.24
3	Vertigo Patients	51-52	170.0	73.17	60.7	22.81	60.3	30.68
7	Vertigo Patients	56-69	58.6**	54.86	32.0*	16.72	25.1*	11.95
			FEMALES					
1	Bilateral LDs	22	11.0	-	15.0	-	15.0	-
2	Bilateral LDs	39-45	18.0	8.00	7.5	0.50	7.5	0.50
1	Ménière's Patient	49	6.0	-	12.0	-	9.0	-
4	Unilateral LDs	33-42	13.3**	2.49	12.5*	0.87	11.3*	1.09
3	Unilateral LDs	54-65	11.3	1.25	12.0	5.35	11.0	3.56
8	Vertigo Patients	20-29	40.8**	66.71	24.6**	14.69	25.5**	17.92
20	Vertigo Patients	32-49	62.6**	62.17	32.8*	21.53	37.4*	29.69
14	Vertigo Patients	50-70	27.7**	14.08	17.9*	7.58	16.5*	7.89

* Indicates significantly different from age-matched normals at ≤ .05 level of confidence, by t test

** Indicates significantly different from age-matched normals at ≤ .01 level of confidence, by t test

performance scores failed to improve with practice. Unusually poor scoring "normals," however, with no evidence of vestibular defects, inevitably improved considerably with practice.

VESTIBULAR STIMULATION EFFECTS

In both normals (2) and bilateral labyrinthine-defectives (3) the ataxia tests were shown to be highly sensitive to moderate doses of alcohol (2.2 cc of 100-proof vodka per kg body weight). Bizarre stimulation of the vestibular apparatus of "normal" subjects during severe storm conditions at sea (4) had the residual effect of reducing ataxia test performance levels significantly as late as 36 hours following return (some 20 hours after the storm subsided) of the ship to port. Results of prolonged rotation at different rpm's in the Pensacola Slow Rotation Rooms under various conditions (in preparation for publication) also indicated high sensitivity of these tests to the stresses of such gravitoinertial force environments.

DISCUSSION

Significant effects of aging upon the ataxia test performance capabilities studied were demonstrated in both the male and female samples. The finding of more rapid falling off of scores with increasing age in females than in males, while statistically significant, must nevertheless be considered tentative pending the testing of larger samples of females. Confirmation of present findings, however, is not unlikely inasmuch as most of the males were "captive volunteers" and, therefore, more randomly sampled than the truly voluntary females.

The factors contributing to the systematic sex differences observed are, as yet, unknown. Most likely, dynamic anthropometric and probably related measures will account for the apparent performance superiority of males. Whatever the underlying sources of sex differences, their investigation in relation to a comprehensive vestibular functional test battery should prove illuminating.

In individuals with unilateral and bilateral labyrinthine-defects and other clinically significant otoneurological defects the discriminative power of the ataxia test battery at the low ends of the distributions of scores compares very well with the discriminative power of the previously reported postural equilibrium test battery conducted on rails of various widths (3,4,7,8). The WALEC and WOFEC procedures alone, when employed with such individuals, appear sufficient to establish clinically significant performance deviations from the quantitative normative standards set forth. There are indications from research in progress that performances on all of these tests relate highly significantly to threshold caloric responses. Because their sensitivity relates very well to caloric as well as to other sensitive vestibular functional tests (6,8), they may serve as rapid and economical procedures for screening. When administered in conjunction with the standing tests (SR and SOLEC) at the expense of only slight addition of testing time, multiple dimensions of ataxia test performance capabilities may be studied readily. As a rapid screening or routine test procedure, one or more of the

ataxia tests may be useful to: 1) otologists, neurologists, and audiologists in juxtaposition with clinical and laboratory findings which present problems of differential diagnosis, 2) military and civilian flight surgeons in aeromedical and aerospace medical evaluations, and 3) vestibular physiological, otoneurological, pharmacological, stress physiological, and gerontological research programs.

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ATAXIA TEST BATTERY ADMINISTRATION AND SCORING PROCEDURES

APPENDIX A

SHARPENED ROMBERG (SR)

All males and the majority of females undertook this test just prior to a postural equilibrium test battery utilizing rails (reference 7 in text). A maximum of 4 trials was administered. Testing was discontinued when the criterion score of 60 seconds' standing time was obtained on any trial. Subjects were permitted to close their eyes at any time after assuming the correct body and foot positions.

A score of 60 seconds on the first trial was weighted 4, and a perfect test score of 240 (60 seconds x 4 trials)* was assigned; a perfect score on the second trial was weighted 3, and 180 (60 x 3)* plus the number of seconds stood on the first trial became the assigned test score; a perfect score on the third trial was weighted 2, and 120 (60 x 2)* plus the number of seconds stood on the first two trials became the assinged test score; with subjects requiring a fourth trial, the total number of seconds stood on the four trials became the assigned test score.

When the SR was administered in conjunction with the postural equilibrium test battery utilizing rails, the fourth trial followed the completion of testing on the rails.

STAND ON ONE LEG EYES CLOSED (SOLEC)

Subjects undertook this test upon completion of the SR. The task consisted of standing on each leg (SOLEC-R and SOLEC-L) with arms folded against chest. A maximum of 5 trials was administered. Testing on each leg was discontinued when the criterion score of 30 seconds was obtained on any trial.

Subjects were not permitted to make this a dynamic test by virtue of moving the standing foot in any way. Rather, it was required that the standing foot remain stationary. However, any amount of movement of the opposite leg or of the body was permitted as long as the body was maintained in an erect or near-erect position. Subjects were permitted to close their eyes at any time after assuming the correct body position. Subjects who violated the static foot requirement were stopped immediately, and number of seconds stood prior to the violation constituted the trial score. Subjects began the test on the leg of their choice. Subjects who required more than one trial on each leg (stood less than 30 seconds) were requested to alternate legs on additional trials in the interest of reducing fatigue.

A perfect score on the first trial was weighted 5, and a perfect test score of 150 (30 seconds x 5 trials)$^{+}$ was assigned; a perfect score on the second trial was weighted 4, and a score of 120 (30 x 4) plus the number of seconds stood on the first trial was assigned; a perfect score on the third trial was weighted 3, and a score of 90 (30 x 3) plus the number of seconds stood on the two previous trials was assigned; a perfect score on

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*Subjects were credited with perfect scores on the remaining, nonadministered trials.
$^{+}$Credit for nonadministered trials was given as for the SR test.

the fourth trial was weighted 2, and a score of 60 (30 x 2) plus the number of seconds stood on the three previous trials was assigned; with subjects requiring a fifth trial, the total number of seconds stood on the five trials became the assigned test score.

WALK A LINE EYES CLOSED (WALEC)

Subjects undertook this test upon completion of the SOLEC. The task consisted of walking as straight as possible a 12-foot long line on the floor at a walking speed typical to the subject, with arms folded against chest and feet tandem, heel-to-toe (shoes on). Trials during which the foot position was violated either by nontandem alignment of feet or by toe not touching heel were not scored. A maximum of 5 non-scorable trials was permitted. Each scorable trial required that subject walk the entire 12-foot distance. Subjects alternated their starting position from trial to trial.

The number of inches of deviation from the line (measured to the nearest inch from the center of the foot) at the end of its 12-foot length constituted a trial score, and the total of the two best trials out of three (best equaled least deviant from the line) constituted the test score. Subjects not meeting the criteria for scorable trials were scored as unable to perform (UTP).

A major limitation of the WALEC procedure is that in notably ataxic individuals the qualitative performance is often more deviant from normal than the individual's score would indicate. Hence, the addition of the WOFEC to the test battery. The WALEC appears to be as much or more a test of spatial orientation than of a test of ataxia.

WALK ON FLOOR EYES CLOSED (WOFEC)

This test and the WALEC were administered simultaneously. The task consisted of walking as straight as possible ten heel-to-toe steps beyond the first two starting steps. A maximum of five trials was administered. The best three out of five trials constituted the score. The maximum test score obtainable was 30 (10 steps x 3 trials).

EYES OPEN TESTS AND THE CLASSICAL ROMBERG

Individuals with unusually poor eyes-closed test performance scores were administered in addition the Classical Romberg (CR) test with eyes closed, followed by the eyes open versions of all test procedures, viz, SR E/O, SOLEO (R and/or L), WALEO, WOFEO, and CR E/O.

APPENDIX B

Sharpened Romberg (SR), Eyes Closed, Raw Scores and Their Percentile Equivalents

Percentile	MALES Age 17-42 (N=427)	MALES Age 43-50 (N=573)	MALES Age 51-53 (N=38)	MALES Age 54-63 (N=7)	FEMALES Age 18-29 (N=83)	FEMALES Age 30-49 (N=87)	FEMALES Age 50-71 (N=24)
99th	240	240	240	240	240	240	240
58th	240	240	240	191	230-239	143	84-142
18th	240	100-104	51-52	34	130-132	31	16-17
15th	216-218	82-86	49	30	92-93	24-27	14-15
10th	192	55-59	48	30	60-61	19-21	13
9th	189-191	48-54	47	30	59	18	13
8th	186-188	42-47	46	30	53-58	17	10-12
7th	184-185	39-41	45	30	52	16	10-12
6th	172-183	37-38	45	0-29	36-51	15	10-12
5th	165-171	32-36	33-44	0-29	25-35	14	6-9
4th	133-164	30-31	30-32	0-29	24	14	6-9
3rd	110-132	26-29	28-29	0-29	20-23	14	6-9
2nd	97-109	21-25	27	0-29	19	10-13	0-5
1st	0-96	0-20	0-26	0-29	0-18	0-9	0-5

APPENDIX C

Stand One Leg Eyes Closed (SOLEC) Raw Scores and Their Percentile Equivalents

Percentile	MALES						FEMALES					
	Age 17-42 (N=215)		Age 43-50 (N=209)		Age 51-53 (N=24)		Age 18-29 (N=41)		Age 30-49 (N=40)		Age 50-71 (N=11)	
	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left	Right	Left
99th	150	150	150	150	150	150	150	150	150	150	150	150
90th	150	150	150	150	150	150	150	150	117-122	111-121	112-149	118-149
83rd	150	150	150	150	135-139	150	150	150	71-81	94-102	56-111	70-117
75th	150	150	128-129	133-134	127	117-132	145-146	150	63-66	82-87	46-55	38-69
58th	150	150	98-99	104	82-94	57-67	119-120	117	47-48	53-54	23-42	24-29
48th	149	150	69	68-69	50	43	106-108	108	40-41	46-47	21-22	24-29
25th	122	116-118	34	36	39-41	29	72-73	66	24-25	24	16-19	18-20
18th	98	104-106	28	29	24	22-28	52	48	19-20	19-20	16-19	16-17
15th	89-95	96-97	26	26	23	22-28	42-51	40-44	17-18	18	16-19	16-17
10th	72	72-76	22	21	21-22	19-21	31-40	38	16	14-17	11-15	13-15
9th	68-71	70-71	21	20	21-22	16-18	31-40	38	16	14-17	11-15	13-15
8th	63-67	67-69	20	19	21-22	16-18	28-30	37	15	14-17	11-15	13-15
7th	61-62	65-66	19	19	21-22	16-18	28-30	37	15	14-17	11-15	13-15
6th	57-60	60-64	18	18	12-20	14-15	28-30	36	15	13	11-15	13-15
5th	52-56	54-59	16-17	18	12-20	14-15	27	36	15	13	0-10	0-12
4th	42-51	42-53	14-15	17	12-20	14-15	27	36	13-14	13	0-10	0-12
3rd	33-41	32-41	13	16	12-20	14-15	20-26	26-35	13-14	12	0-10	0-12
2nd	30-32	26-31	12	14-15	0-11	0-13	20-26	26-35	13-14	12	0-10	0-12
lst	0-29	0-25	0-11	0-13	0-11	0-13	0-19	0-25	0-12	0-11	0-10	0-12

APPENDIX D

Walk a Line Eyes Closed (WALEC)

Scores and Their Percentile Equivalents

(N = 181 Males and 97 Females)

Percentile	Score
99th +	
99th	1
96th	2
91st	3
85th	4
79th	5
72nd	6
63rd	7
58th	8
53rd	9
49th	10
41st	11
33rd	12
27th	13
25th	14
22nd	15
19th	16
14th	17
12th	18
10th	19
8th	20
6th	21-23
5th	24
4th	25
3rd	26-27
2nd	28-30
1st	31

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13. ABSTRACT

Normative standards on a new quantitative ataxia (postural equilibrium) test battery using rails of various widths as platforms were presented in a previous report. The present study reports normative standards of performance on a related battery of ataxia tests with the floor as a platform and employed routinely in the vestibular research program at this laboratory.

Significant decreases in performance with age and an apparent superior performance by males were found. The scores of bilateral and unilateral vestibular-defective individuals and of patients referred for testing because of symptoms of vertigo departed significantly from the normative standards. The usefulness of individual tests as well as of the test battery in clinical and research situations was made apparent.

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